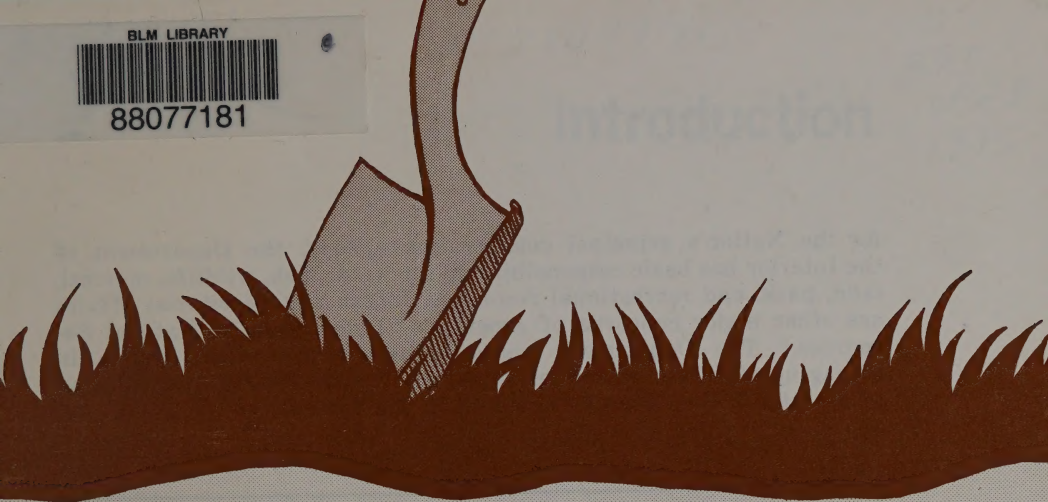


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Soils and the Art of Collecting a Soil Sample

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As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources." The Department works to assure the wisest choice in managing all of our resources so each will make its full contribution to a better United States—now and in the future.

Library of Congress Cataloging in Publication Data

Fenn, Dennis B

Soils and the art of collecting soil samples.

(Ecological services bulletin; no. 2)

Bibliography: p.

Supt. of Docs. no.: I 29.3/3:2

1. Soils—Sampling. 2. Soil formation. I. Title. II. Series.

S593.F23

631.4'028

75-619110

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ECOLOGICAL SERVICES BULLETIN, NUMBER 2

U.S. Department of the Interior

National Park Service

Washington, D.C. 1975

1342361

ID: 88077181

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Introduction

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The word soil has several meanings and may be used in many ways. To a housewife it may mean "to make dirty," while to an engineer it is the critical support medium for his structures. To many people, soil is the substance which supports and sustains plant life. As a general definition, soil is the loose material that covers the Earth's surface as opposed to the solid rock portion. Just as experiences within the National Park Service vary greatly, so are National Park Service personnel in the position of applying the diverse meanings of the word soil.

When interpreting soil to mean the loose material covering the Earth's surface and preparing to obtain a sample of this soil, it is important that one knows the purpose for which the sample is being taken. If the engineering properties are needed, one would probably sample the soil differently than he would if he desired soil-fertility information.

Understanding Soils

Prior to stating specific procedures about soil sampling, it may be worthwhile to discuss briefly several factors which affect the process of soil development and cause each soil type to exhibit its own unique set of physical and chemical properties.

Soil is a mixture of four components in most natural environments: mineral matter, organic matter, air, and water. The quantity of each component varies greatly from one soil to another and the properties of different soils reflect this variation. An ideal loam-textured soil, for example, will consist of approximately 45% mineral matter, 5% organic matter, 25% air-filled pores, and 25% water-filled pores on a volume basis. The volume of water and air in a soil bear a direct inverse relationship to each other. As water moves into a soil, it forces air out. Since roots need air as well as water, good drainage is necessary for the growth of most plant species. Organic matter generally decreases with depth in a soil. Surface soils are usually darker than the underlying subsoil due to higher organic-matter content near the surface. In low-lying, swampy areas, muck or peat soils are often found and they contain more organic matter than mineral matter. Many sandy soils, particularly beach and dune sands, are almost devoid of any measurable organic-matter content. Most soils, however, are mixtures of the above-mentioned four components.

Soil has been scholastically defined in the 1957 *USDA Yearbook* as "A natural body of the Earth's surface having properties due to the integrated effect of climate, and living matter (plants and animals), acting upon parent material, as conditioned by relief (slope), over periods of time." Simply stated, five factors govern the development of soils. These are: (1) parent material; (2) climate; (3) slope; (4) organic matter; and (5) time. Most soil scientists now add a sixth factor to the list, namely, man. In one day man can alter what it has taken nature millions of days to create. None of the six factors is independent. With the possible exception of man, they operate simultaneously and are interdependent, although all do not have equal importance in every environment.

Parent material refers to the original substance from which the soil has developed. It can be volcanic lava or ash, unconsolidated wind or water deposits, solid rock formations such as granite, limestone, or sandstone, or it may be deposits laid down by the action of glaciers. The forces of nature decompose consolidated parent material over geologic time to produce what we call soil material.

Climate is very important in soil development. Rainfall affects the pathway of the weathering process on parent material. High rainfall tends to leach released minerals out of a soil, producing acid conditions and low fertility. Low rainfall leads to the accumulation of basic minerals and calcium carbonate deposits. Wind conditions can affect the erosional history of a soil profile. Temperature affects the rate of soil development. Glaciation has had a great impact on soil development in many parts of the world. Obviously then, climate is an important factor in soil-forming processes.

Under favorable climatic conditions, plants will establish themselves on the parent material of a developing soil. It has been shown, for example, that abundant vegetation will grow on volcanic debris within 10 years after its deposition. Organic matter from plants and animals accumulates on the surface of parent materials. Bacteria, fungi, and soil animals enter the ecosystem and feed on the organic residues, releasing nutrients for use in a new trophic cycle. This gradual accumulation of organic matter causes the surface to become darker in color than the original parent material. The soil now has two layers: a dark surface with accumulated organic matter, and a lighter sub-surface of parent material. Structural stability and nutrient fer-

tility are both enhanced by the presence of organic matter in the soil.

The topographic relief or slope of the land is also critical to the process of soil development. Soils on mountainsides and steep slopes are invariably shallow. The steeper the slope, the thinner the soil layer. This is due to the increased erosion hazard associated with steep slopes. The water runoff velocity increases with slope and, hence, erosion increases also, keeping the soil depth from increasing significantly. In contrast, soil deposits on flood plains and level areas are often quite thick.

A common factor co-dominant with each of the four previous factors is time. Like all dynamic natural entities, soil has a definite life cycle. The four stages in the life cycle of a soil are: (1) parent material; (2) immature soil; (3) mature soil; and (4) old age. Figure 1 shows the general appearance of each of these stages in the life cycle of a soil. Depending upon rainfall, the life cycle probably will require several hundreds or thousands of years to complete. Due to erosion, deposition, and geologic upheaval, most soils never complete the entire life cycle. The most productive and stable soil occurs during the mature stage. The immature stage will support plant life but not as well as the mature stage. The old-age stage is heavily leached, infertile, and often rock hard due to concentrated iron oxide deposits. Old age is not a desirable soil condition. Fortunately, it is not a very common occurrence in nature.

One of the most significant advances in soil science occurred with the recognition and discovery that soils are composed of horizontal layers or "horizons" that roughly parallel the surface. Horizons are identified by the letters A, B, or C, with the A horizon being at the soil surface. Each of these horizons differ from the one above or below it in physical, chemical, and biological properties. Figure 1C shows a general soil profile of a well-developed soil. The A horizon is the zone of high biotic activity and organic matter accumulation and is usually darker in color than the subsoil. In some forest soils the lower part of the A horizon has been leached out and has a bleached or light-colored appearance. In this case the A horizon is subdivided into A1 and A2 horizons. The B horizon is a zone of colloidal accumulation. Clay, organic matter, and oxides of iron and aluminum collect in this zone. It is often redder in color and has a higher clay content than the soil horizons above or below it. The C horizon is usually unconsolidated but largely unweathered parent material.

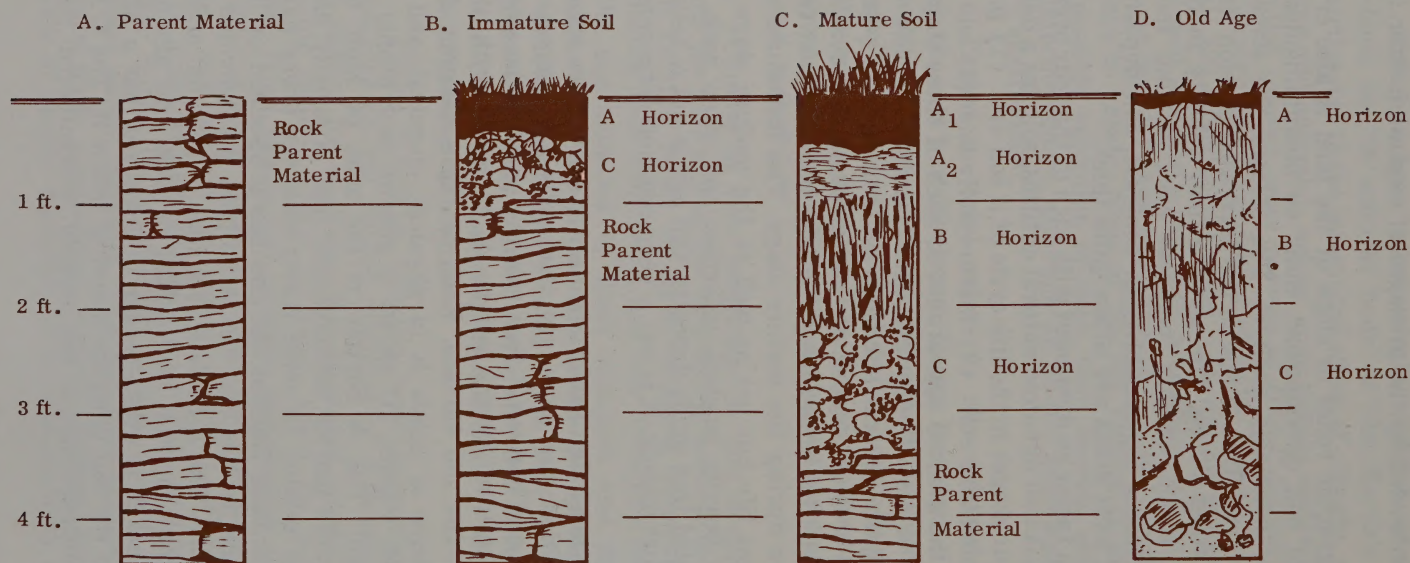


FIGURE 1. *Stages in the life cycle of a soil.*

It is important to recognize the horizontal make-up of the soil profile when sampling soil for analysis. If soil fertility is to be determined, it should be remembered that as plant roots grow through one horizon into the next layer, they enter a zone that may differ considerably from the one above. The soil sample should be collected from the zone in which the majority of the plant root system proliferates. When sampling for engineering data, however, we must sample the horizon that will be most limiting to the functioning of the structure to be built. With soils, it sometimes truly can be said that beauty is only skin deep. What you see at the surface is not always what you get. It is a good practice to examine the subsurface soil horizons before making any management decisions.

Sampling Procedure

1. The most important thing to remember when sampling a soil is to determine your objectives prior to collection and then to design your collection technique to achieve the stated objectives.

2. Roughly map the area to be sampled on a sheet of paper. Figure 2 is an example of what a typical sampling area might look like. The 3-acre area has two different soil types present and they are being sampled separately because of their apparently different properties. This information would be obtained by visiting the area and checking the soil profiles prior to designing the sampling technique. Design the sampling pattern and mark the subsampling locations on the map as shown in Fig. 2. Be attentive to significant changes in topography and vegetative cover. Areas showing significant differences should be sampled separately, as in Fig. 2, provided the areas are of such size and nature that they can be treated separately during actual maintenance operations.

3. A maximum area of 3 acres should be allowed per soil sample. Areas larger than this should be subdivided into smaller areas and sampled separately. Figure 2 shows seven subsamples in sample area A and six subsamples in area B. Do not confuse subsamples with samples. Only one sample is submitted for analysis from area A and only one sample from area B. Step 8 describes the sampling process in detail.

4. Determine the depth to which the subsamples should be collected. If, for example, the samples are to be collected for fertility analysis and the predominate plants are grass species, the sample need be taken only from the top 3-5 inches of soil since this is the zone of greatest root growth. However, if trees and larger shrubs are the major plant types present, then the surface 18-24 inches should be sampled. When samples are to be collected for analysis of soil moisture properties, each individual layer (horizon) within the soil profile should be sampled because of the variation of moisture properties with depth. The most densely compacted horizon will be the layer limiting the movement of water through the soil. It is, therefore, very important that the purpose of the sample collection be carefully considered when deciding from what depth to collect the soil sample.

5. The equipment needed to take a soil sample includes a shovel, a sample container (plastic bag, paper bag, clean milk carton, etc.; avoid glass containers due to the danger of breakage), a tablespoon, a notebook, and a pencil to record pertinent identifying data about the samples taken.

6. The final volume of each sample submitted for fertility analysis need not exceed one pint.

7. The best time to obtain soil samples is in the summer or fall when the soil nutrients are in their most stable condition. Avoid sampling on rainy days.

8. At the first subsampling point within a given sampling area, one or two spades of soil should be taken from the appropriate horizons, as determined in step 4, and mixed together thoroughly. A few tablespoons of this soil should then be placed in the sample container. This process should be repeated at each subsampling point in the sampling area (7 subsampling points in area A, Fig. 2). The final sample that will be submitted for analysis, then, is a mixture of several tablespoons of soil from each subsampling location within the sampling area.

9. Soil samples submitted for analysis should be air dried. They should not be dried in an oven before submittal, nor should they be overly wet. If the samples are moist, they can be spread out on a clean sheet of paper indoors and dried for 24-36 hours prior to submittal to the laboratory.

10. Each sample submitted should be carefully, completely, and clearly marked for accurate identification. Keep a record of

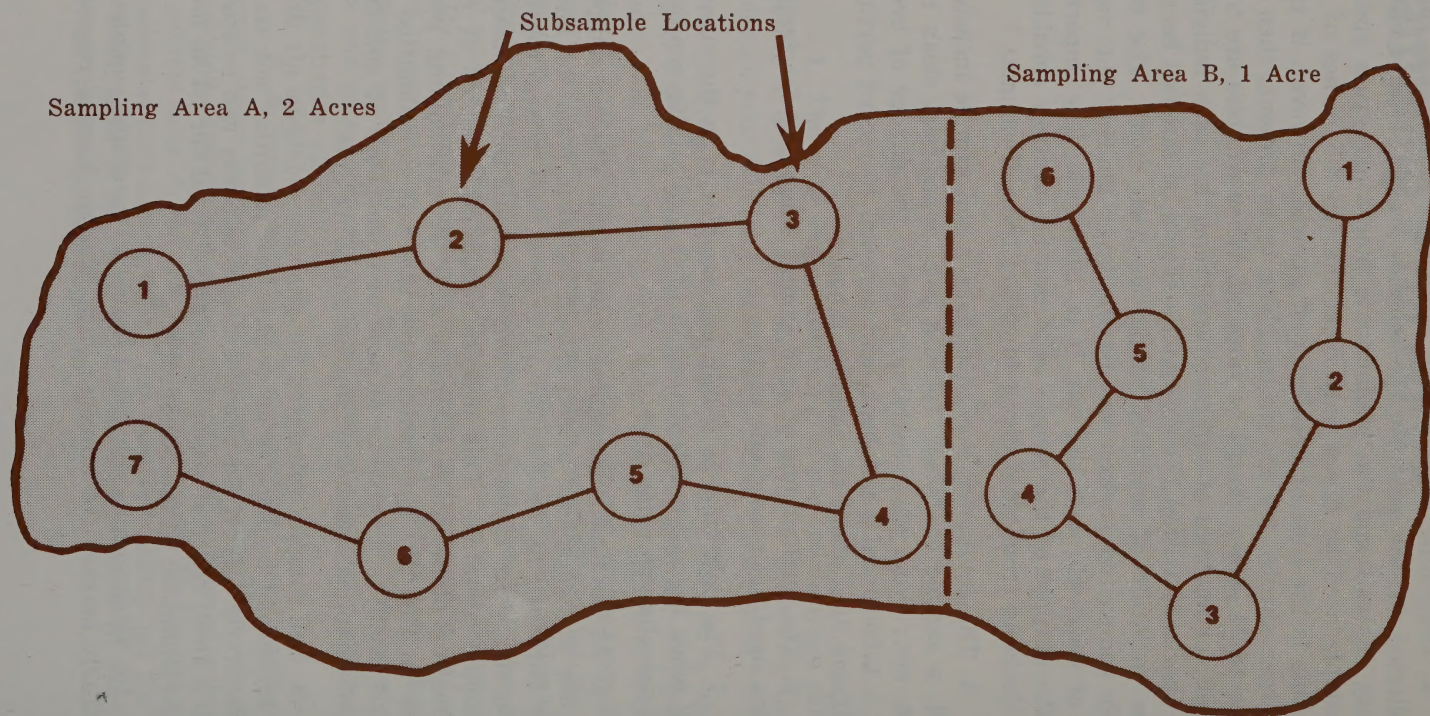


FIGURE 2. *Outline map of area from which soil samples are to be collected.*

each sample identification for your own information and later referral.

11. Promptly submit the samples to an analytical laboratory for analysis. Be sure to indicate what types of analysis you desire and what type of treatments you propose to perform on the soils in the areas sampled.

12. Dirt has been defined as "soil out of place." A poor sample collection procedure can result in your collecting a "dirt" sample rather than a soil sample, and failing to get analytical data which will be of true value to you in solving your problem.

13. The dynamic nature of soils and the effects of added soil amendments make it important to sample soils on a periodic schedule. Depending upon the type of soil and its use, a schedule of every 3-5 years is recommended for most circumstances.

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